PHYS 5383
Spring 2013
TE Coan
Due: 29 Mar '13 6:00 pm

Homework 3

1. An electron is in the ground state of tritium, a radioactive isotope of hydrogen with a nucleus that contains 1 proton and 2 neutrons. A nuclear reaction simultaneously changes the nucleus to He^3, that is, 2 protons and 1 neutron. Find the probability P that the electron remains in the ground state of He^3.

2. Show that the coefficient A for the function $u(r) = A \sin kr + B \cos kr$ that satisfies the radial equation for the infinite spherical well with $l = 0$ is $A = \sqrt{2/a}$, where a is the radius of the well.

3. Consider the case of an exotic atom composed of a proton orbited by a negative muon μ^-. What is the ionization energy I_0, measured in eV, required to ionize this atom? You can assume the μ^- is in its lowest energy state. Unlike a hydrogen atom, this exotic atom does not last too long since the muon will decay after about $2.2\,\mu$sec.

4. Suppose we now have an atom of positronium, a bound state of a positron e^+ and a plain vanilla electron e^-. What are the wavelengths, measured in nanometers, of the three *least* energetic Balmer series transitions? Balmer series transitions are those for which the final principal quantum number $n_f = 2$. (See your text or even any modern physics text for the names of other transitions.) In hydrogen, these are the transitions you can see with your naked eyeball and you may have seen them in PHYS 1106.. For the positronium, indicate whether or not you can see the light produced by these transitions with your unaided eye and justify your answer.